



## A HOCKEY STICK BLADE

### Field of the invention

- 5 The present invention relates to a hockey stick blade comprising front and rear surfaces having a layer of thermoplastic material.

### Background of the invention

- 10 Typical hockey stick blades or replacement blades are generally made of a wooden core reinforced with one or more layers of synthetic material such as fiberglass, carbon fibers or graphite. The core of the blade may also be made of a synthetic material reinforced with layers of fibers material. The layers are usually made of woven filament fibers, typically soaked in a resin and glued to the surfaces of the core  
15 of the blade. Expandable fibers braids may also be used for recovering the core of the blade.

- Canadian Patent Application 2,228,104 discloses a hockey stick comprising a wooden shaft and a composite blade with a pre-form core made of thermoplastic polyurethane  
20 foam. The pre-form core is recovered of braided glass socks and layers of reinforcing materials.

- U.S. Patent 5,048,878 discloses an expanded polyvinyl chloride foam core stick wherein the core is covered with meshes of fiberglass or carbon fibers.

- 25 U.S. Patent 5,333,857 discloses a hockey stick comprising a shaft section, a blade section and a heel section forming the connection between the blade and shaft sections. The stick comprises a core made of synthetic foam having a first density for the shaft, a second density for the heel and a third density for the blade. The core is  
30 covered with three layers of woven materials.

There is a demand for an improved hockey stick blade having a better impact resistance.

### **Summary of the invention**

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As embodied and broadly described herein, the invention provides a hockey stick blade with a shank and a blade element having a front surface and a rear surface. The blade comprises a core of synthetic material extending along a longitudinal axis, a layer of fibers recovering at least partially the core of synthetic material and a layer of thermoplastic material recovering at least partially the layer of fibers. The layer of thermoplastic material forms part of one of the front and rear surfaces of the blade element.

As embodied and broadly described herein, the invention provides a hockey stick blade with a shank and a blade element having a front surface and a rear surface. The hockey stick blade comprises a core of synthetic material extending along a longitudinal axis and a layer of fibers recovering at least partially the core of synthetic material. One of the front and rear surfaces of the blade element comprises a layer of thermoplastic material that recovers at least partially the layer of fibers.

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Other objects and features of the invention will become apparent by reference to the following description and the drawings.

### **Brief description of the drawings**

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A detailed description of the embodiments of the present invention is provided herein below, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a hockey stick blade constructed in accordance with the invention;

Figure 2 is a perspective view of the blade of Figure 1 with layers being peel off;

Figure 3 is a perspective view of first and second core portions used in the construction of the blade of Figure 1;

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Figure 4 is a cross sectional view taken along line 4-4 of Figure 1;

Figure 5 is a perspective view of the first and second core portions of Figure 4 with first and second fibers braids used in the construction of the blade of Figure 1;

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Figure 6 is a perspective view of the first and second core portions and first and second fibers braids of Figure 5 with a further fibers braid used in the construction of the blade of Figure 1;

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Figure 7 is a perspective view of the first and second core portions and the fibers braids of Figure 6 with a further fibers braid used in the construction of the blade of Figure 1;

Figure 8 is a perspective view of the blade of Figure 1 before the molding operation;

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Figure 9 is a cross sectional view taken along line 9-9 of Figure 8;

Figure 10 is a perspective view of the preformed blade of Figure 8 with sheets of thermoplastic material used in the construction of the blade of Figure 1; and

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Figure 11 is a perspective view of a mold and the preformed blade with the sheets of thermoplastic material.

In the drawings, the embodiments of the invention are illustrated by way of examples.

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It is to be expressly understood that the description and drawings are only for the purpose of illustration and are an aid for understanding. They are not intended to be a

definition of the limits of the invention.

**Detailed description of the embodiments**

5 To facilitate the description, any reference numeral designating an element in one figure will designate the same element if used in any other figures. In describing the embodiments, specific terminology is resorted to for the sake of clarity but the invention is not intended to be limited to the specific terms so selected, and it is understood that each specific term comprises all equivalents.

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Figures 1 and 2 illustrate a hockey stick blade 10 constructed in accordance with the invention. The blade 10 comprises a shank 12, a heel section 14 and a blade element 16. The heel section 14 is located at the junction of the shank 12 and the blade element 16. The shank 12 comprises a tenon 18 adapted to be inserted into a hollow  
15 hockey stick shaft made of aluminum, composite or graphite. It is understood that instead of having the tenon 18, the shank 12 can be integrally formed with a hockey stick shaft.

The blade 10 comprises a top edge 20, a tip edge 22 and a bottom edge 24. The blade  
20 10 also comprises a front surface 26 defined by the front surface of the blade element 16 and the front surface of the shank 12; and a rear surface 28 defined by the rear surface of the blade element 16 and the rear surface of the shank 12.

As shown in Figures 3 and 4, the blade 10 comprises a core 30 extending along a  
25 longitudinal axis A-A. The core 30 comprises a first portion 32 located above and aligned with a second portion 34. The first and second portions 32, 34 are dimensioned such as to have the shape of a blade when aligned with one another.

The first portion 32 comprises a bottom surface 36 and extends from the heel section  
30 14 to the tip edge 22. The first portion 32 is generally delimited by its bottom surface 36 and the planes defined by the top and tip edges 20, 22. The second portion 34

comprises a top surface 38 and extends from the heel section 14 to the tip edge 22. The second portion 34 is generally delimited by its top surface 38 and by the planes defined by the bottom and tip edges 24, 22. As shown in Figure 3, the first and second portions 32, 34 may further comprise respective shank portions 40, 42 defining the core of the shank 12, these shank portions 40, 42 comprising respective tenon portions 44, 46. The shank portions 40, 42 generally extend upwardly and rearwardly from the heel section 14. Hence, the core 30 comprises the first portion 32 with its shank portion 40 and the second portion 34 with its shank portion 42.

It is understood that the core may comprise first and second portions that do not comprise respective first and second shank portions. In fact, the first and second portions of the core may be confined to the blade element of the hockey stick blade (from the heel section to the tip edge) and the shank may be a separate component that is joined to the blade element. For example, the shank may be made of wood and comprises a groove in which a tongue portion provided on the blade element is inserted for joining together both components.

The first and second portions 32, 34 are made of synthetic material such as a thermo-expandable foam selected in the group consisting of polyurethane foam, ethylene vinyl acetate (EVA) foam, polyvinyl chloride (PVC) foam, ethylene polypropylene foam and polyisocyanurate foam. For example, the first and second portions 32, 34 may be made of thermo-expandable polyurethane foam sold by General Plastic Manufacturing. The first and second portions 32, 34 may be cut from a sheet of foam. Liquid foam may also be injected in a mold in order to form the first and second portions 32, 34.

The second portion 34 may be made of foam having a higher density than the one of the first portion 32. For example, the first portion 32 may be made of foam having a density of between 6 to 12 lbs/cubic foot while the second portion 34 may be made of foam having a density of between 14 to 18 lbs/cubic foot. In one possible embodiment, the first portion 32 is made of foam having a density of 10 lbs/cubic foot

and the second portion 34 is made of foam having a density of 15 lbs/cubic foot.

As shown in Figure 3 and 4, the bottom surface 36 of the first portion 32 and the top surface 38 of the second portion 34 extend generally along an irregular line. More particularly, the top surface 38 of the second portion 34 extends beyond the longitudinal axis A-A in the heel region such that the heel region of the blade 10 is mostly made of higher density foam. In the tip region, the bottom surface 36 of the first portion 32 extends beyond the longitudinal axis A-A such that the tip region of the blade 10 is mostly made of lower density foam in order to reduce the weight of the blade 10.

In another embodiment, the bottom and top surfaces of the respective first and second portions may both extend along the longitudinal axis of the blade.

In a further embodiment, the first and second portion 32, 34 may be made of a thermo-expandable foam of same density.

It is understood that the core 30 may be made of a single piece that is dimensioned such as to have the shape of the blade. This single piece may be cut from a sheet of foam. Liquid foam may also be injected in a mold in order to form a foam core having the shape of the blade.

A method of making the blade 10 is hereinafter described. As shown in Figure 5, a first fibers braid 48 is wrapped over the first portion 32 and a second fibers braid 50 is wrapped over the second portion 34. As shown in Figure 6, a third fibers braid 52 is wrapped over the second fibers braid 50 of the second portion 34. As shown in Figure 7, a fourth fibers braid 54 is wrapped over the first and third fibers braids 48, 52 of the first and second portions 32, 34 such as to realize a preformed blade 56 as illustrated in Figure 8. Note that the preformed blade 56 has the general shape of a straight hockey stick blade and comprises front and rear faces 58, 60.

The fibers braids 48, 50, 52, 54 are expandable so as to conform to the shape of the first and second portions 32, 34 and are made of woven fibers selected from the group consisting of carbon fibers, glass fibers, KEVLAR fibers, ceramic fibers, boron fibers, quartz fibers, spectra fibers, polyester fibers and polyethylene fibers. For instance, a  
 5 3K carbon fibers braid, medium weight, commercialized by A & P Technology or Eurocarbon may be used. Moreover, the fibers braids 48, 50, 52, 54 may be made of fibers crossing at 45°. However, any other fibers crossing at between 30° and 60° may be used. Alternatively, layers of uni-directional or woven fiberglass, layers of uni-directional or woven carbon fibers or sheets of fibers may be used for covering the  
 10 core 30. In another alternative construction, pre-impregnated expandable fibers braids may be used for covering the core 30.

Figure 9 shows a cross section view of the preformed blade 56 for illustrating the fibers braids before the molding process.

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As shown in Figure 10, front sheet 62 and rear sheet 64 are used for covering the respective front and rear faces 58, 60 of the preformed blade 56 in the construction of a blade 10. The sheets 62, 64 are made of a thermoplastic material selected in the group consisting of polyethylene, polyurethane, polypropylene, polyester, polystyrene,  
 20 polyvinyl chloride and cellulose acetate. For example, the thermoplastic sheets 62, 64 may be made of thermoplastic polyurethane (TPU) sheets sold by Isosport IS under the name ISOCAP (density of 1.11 gr/cc and hardness of 73D) or sold by Dow Chemical (density of 1.15-1.25 gr/cc and hardness of 73D).

25 Each of the thermoplastic sheets 62, 64 may have a contour that is slightly larger than that of the preformed blade 56 such that portions of the thermoplastic sheets 62, 64 covers the edges of the preformed blade 56. One of the sheets 62, 64 may comprise an indicia 66 that has been marked, engraved or printed thereon as shown in Figure 10 (see the trade-mark SWOOSH Design of Nike). It is also understood that the contour  
 30 of the sheets of thermoplastic material may be smaller than that of the preformed blade 56. Moreover, the sheets of thermoplastic material may only recover specific

regions of the preformed blade 56. For example, only the regions of the preformed blade 56 that are more subject to impacts may be recovered with the sheets of thermoplastic material. In one embodiment, only the front face 58 may be recovered with a sheet of thermoplastic material; and such a sheet may entirely recover the front face 58, or only a specific region of this front face 58 (only the heel region of the front face for example).

The preformed blade 56 and the thermoplastic sheets 62, 64 are afterwards inserted in a mold having the shape of the blade 10. A suitable resin (urethanes, araldite epoxy, vinyl ester, polycyanate or polyester resin) is then injected into the mold to impregnate the expandable fibers braids 48, 50, 52, 54 and heat is applied to the mold. A resin such as the resin sold by Ciba Specialty Chemicals Inc. under the name RESINFUSION may be used. The temperature of the mold may be between 85°C and 125°C, the injection pressure of the resin may be between 25 psi and 75 psi and the injection temperature of the resin may be between 20°C and 30°C. A vacuum pump may be mounted on the mold for easing the flow of resin through the fibers braids. Owing to the shape to the internal cavity of the mold, the preformed blade 56 is curved to any desired curvature typically used by hockey players such as to obtain the blade 10.

When the resin is cured, the mold is opened and the blade 10 is removed. Excess resin and material along the edges of the blade are removed with quick trimming and sanding operations.

Once the resin is injected in the fibers braids and the fibers-resin matrix is cured (see large lines on Figure 4), the blade 10 comprises an interface between the first and second portions 32, 34, this interface comprising fibers oriented transversely relative to the longitudinal axis A-A.

As best shown in Figures 2 and 4, the blade 10 comprises (a) the core 30 formed of the first and second portions 32, 34; (b) a layer of fibers 68 recovering the core 30,



this layer being formed of a first layer of fibers comprising the fibers braids 48, 50, 52 and a second layer of fibers comprising the fibers braid 54; and (c) a layer of thermoplastic material 70 recovering the layer of fibers. It is understood that, when the resin is cure, the layer of fibers 68 comprises fibers impregnated into the resin (see large lines in Figure 4).

The layer of thermoplastic material 70 comprises the front and rear sheets 62, 64 and forms part of the front and rear surfaces of the blade element 16 and the front and rear surfaces of the shank 12 (i.e. front and rear surfaces 26, 28). In other words, the front and rear surfaces of the blade element 16 and the shank 12 comprise the layer of thermoplastic material 70, more precisely, the respective front and rear thermoplastic sheets 32, 34. Should the front and rear thermoplastic sheets 62, 64 have a shape that is slightly larger than that of the preformed blade 56, then the layer of thermoplastic material 70 may also cover the edges of the preformed blade 56 and forms part of the edges 20, 22, 24 of the blade 10.

As indicated previously, the contour of the thermoplastic sheets 62, 64 may be smaller than that of the preformed blade 56 such that the layer of thermoplastic material may only cover specific regions of the blade 10. For example, only the regions of the blade 10 that are more subject to impacts may be covered with the layer of thermoplastic material. In one embodiment, only the front surface 26 of the blade may be formed of a thermoplastics layer. Indeed, it is known that the front surface of the blade is more subject to impacts. In another embodiment, only specific regions of the front surface 26 may be formed of a thermoplastic layer (only the heel and middle regions of the blade 10 for example).

Because the front and rear surfaces 26, 28 of the blade 10 comprises the layer of thermoplastic material 70, the impact resistance of the blade 10 is greater than that of a blade having no external layer of thermoplastic material. For example, for the same blade construction, drop tests shown that the impact resistance increases of at least 50% for a blade having an external layer formed of a thermoplastic polyurethane

(TPU) sheet sold by Isosport IS under the name ISOCAP and at least 70% for a blade having an external layer formed of a thermoplastic polyurethane (TPU) sheet sold by Dow Chemical (density of 1.15-1.25 gr/cc and hardness of 73D).

- 5 The above description of the embodiments should not be interpreted in a limiting manner since other variations, modifications and refinements are possible within the spirit and scope of the present invention. The scope of the invention is defined in the appended claims and their equivalents.